US009429898B2

(12) **United States Patent**
Taguchi et al.

(10) **Patent No.: US 9,429,898 B2**
(45) **Date of Patent: Aug. 30, 2016**

(54) **DEVELOPING CARTRIDGE INCLUDING ELECTRODE AND PROTRUSION**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/851,021**

(22) Filed: **Sep. 11, 2015**

(65) **Prior Publication Data**

US 2016/0223983 A1 Aug. 4, 2016

(30) **Foreign Application Priority Data**

Jan. 30, 2015 (JP) 2015-017786

(51) **Int. Cl.**
G03G 21/18 (2006.01)
G03G 15/08 (2006.01)
G03G 21/16 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 21/1652*** (2013.01); ***G03G 15/0865*** (2013.01); ***G03G 21/1867*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 21/1867–21/1871
See application file for complete search history.

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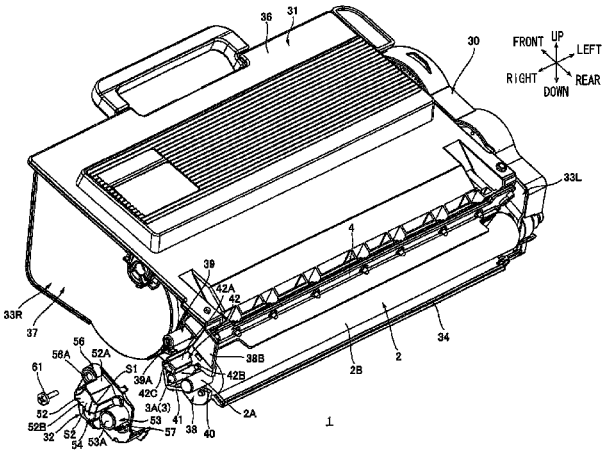
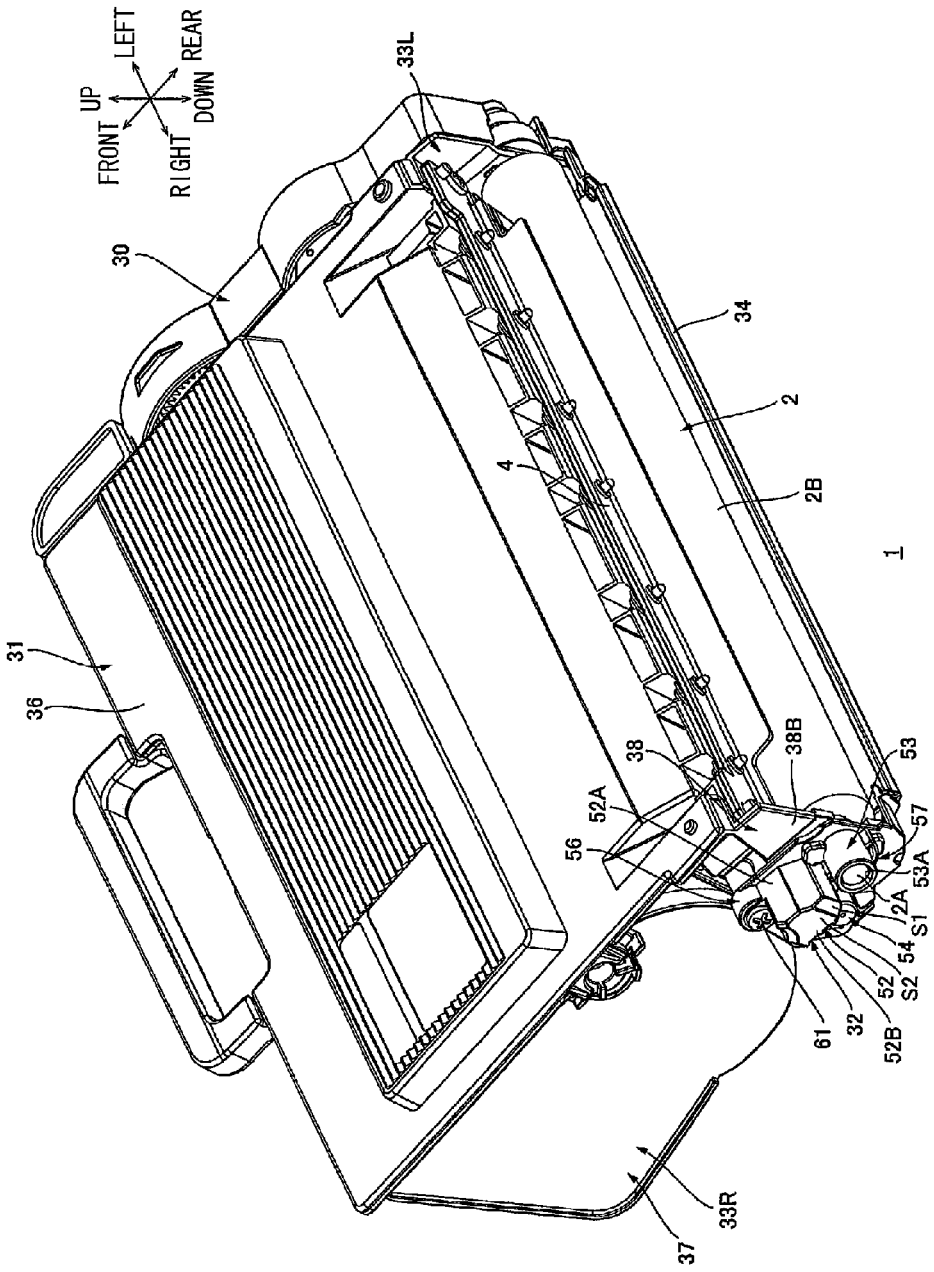
(57) **ABSTRACT**

A developing cartridge may include a casing, a developing roller, a first protrusion, and an electrode. The casing may be configured to accommodate developer therein. The developing roller may include a developing roller shaft extending in a first direction. The first protrusion may be positioned at an outer surface of the casing. The first protrusion may protrude outward from the outer surface in the first direction. The electrode may be positioned at the outer surface. The electrode may be configured to be electrically connected to the developing roller shaft. The electrode may include a second protrusion protruding outward in the first direction. The second protrusion may have an inner space extending in the first direction. The inner space may be positioned in the second protrusion. The first protrusion may be positioned in the inner space.

15 Claims, 10 Drawing Sheets

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2B
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38B
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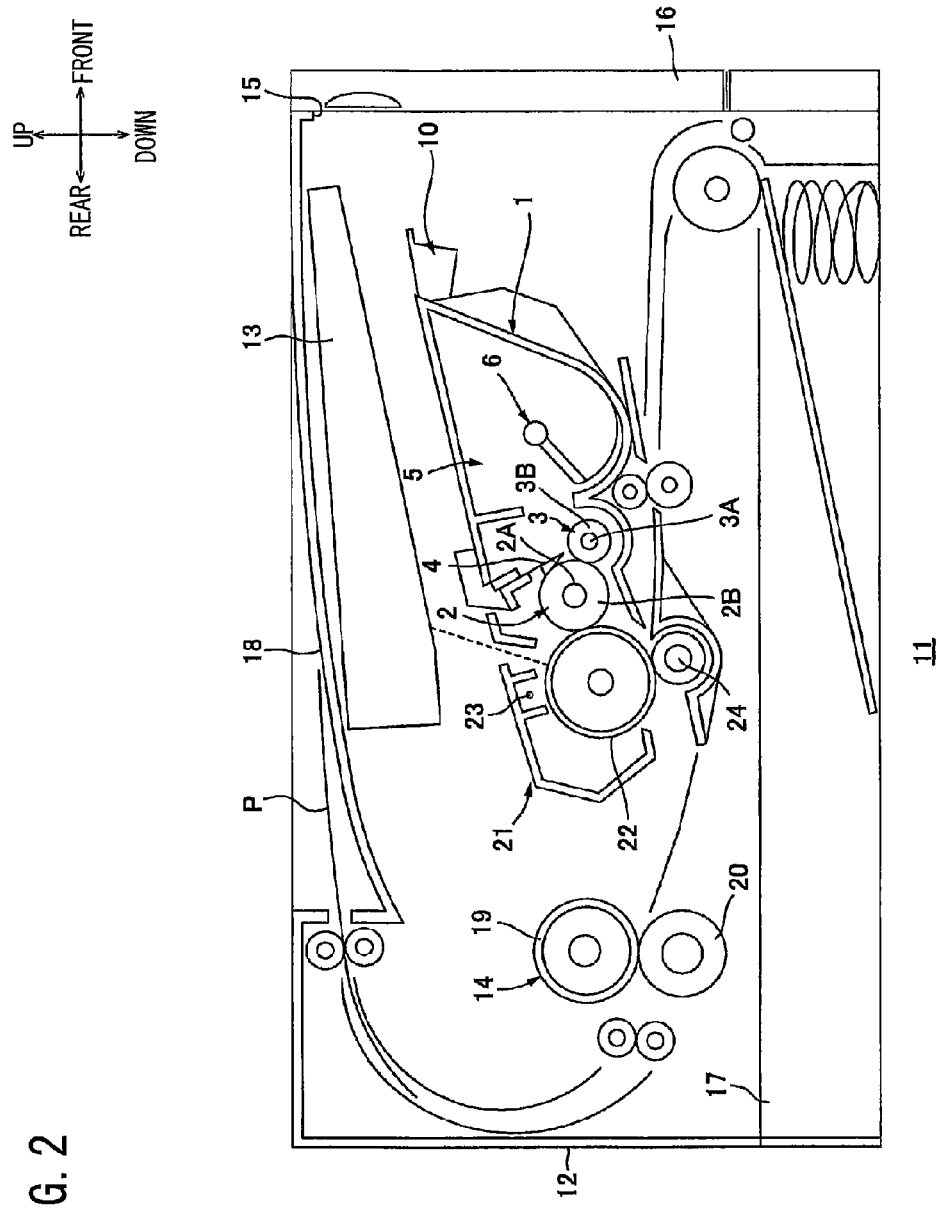
57
53A
2A
S1
54
52
S2
61
32
52B
33R
37

FIG. 1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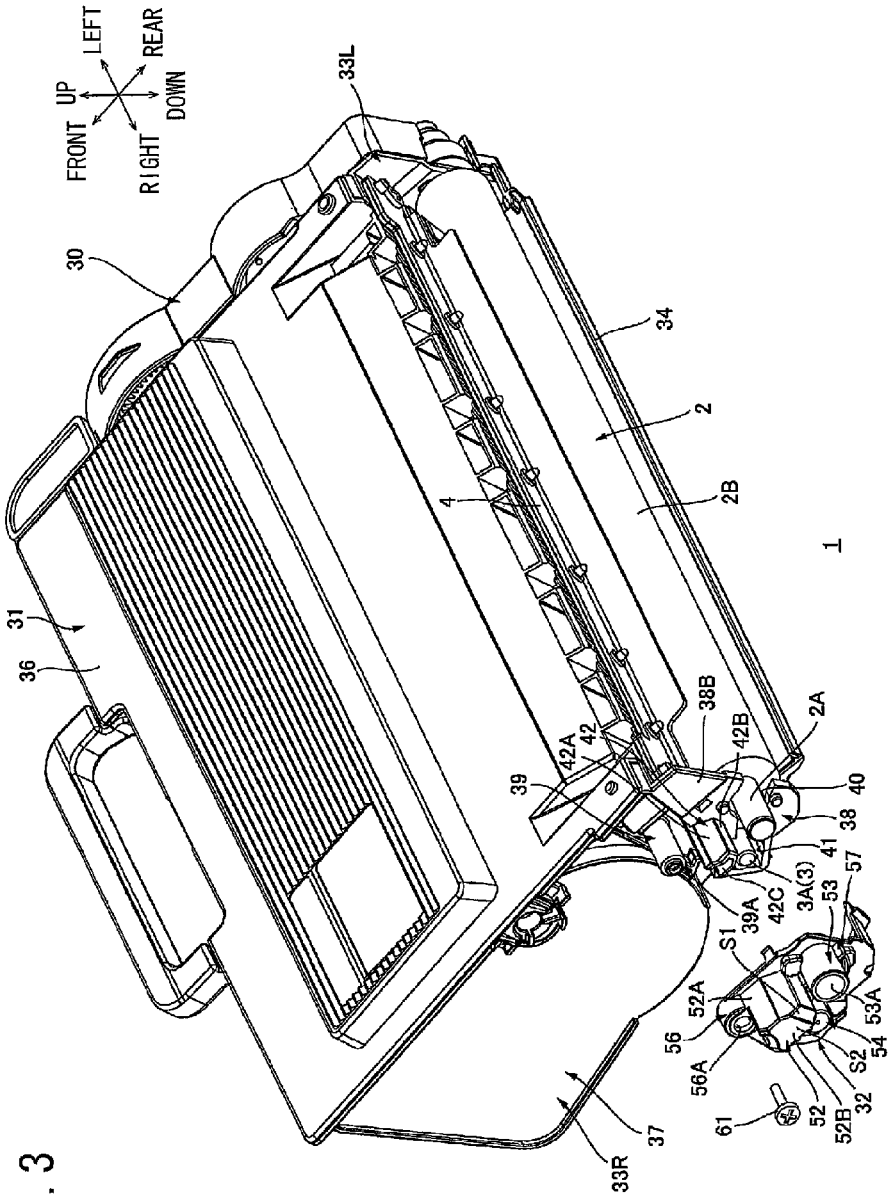
18
23
24
P
21
22
20
19
14
17
12
11

FIG. 2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38B
42B
2A
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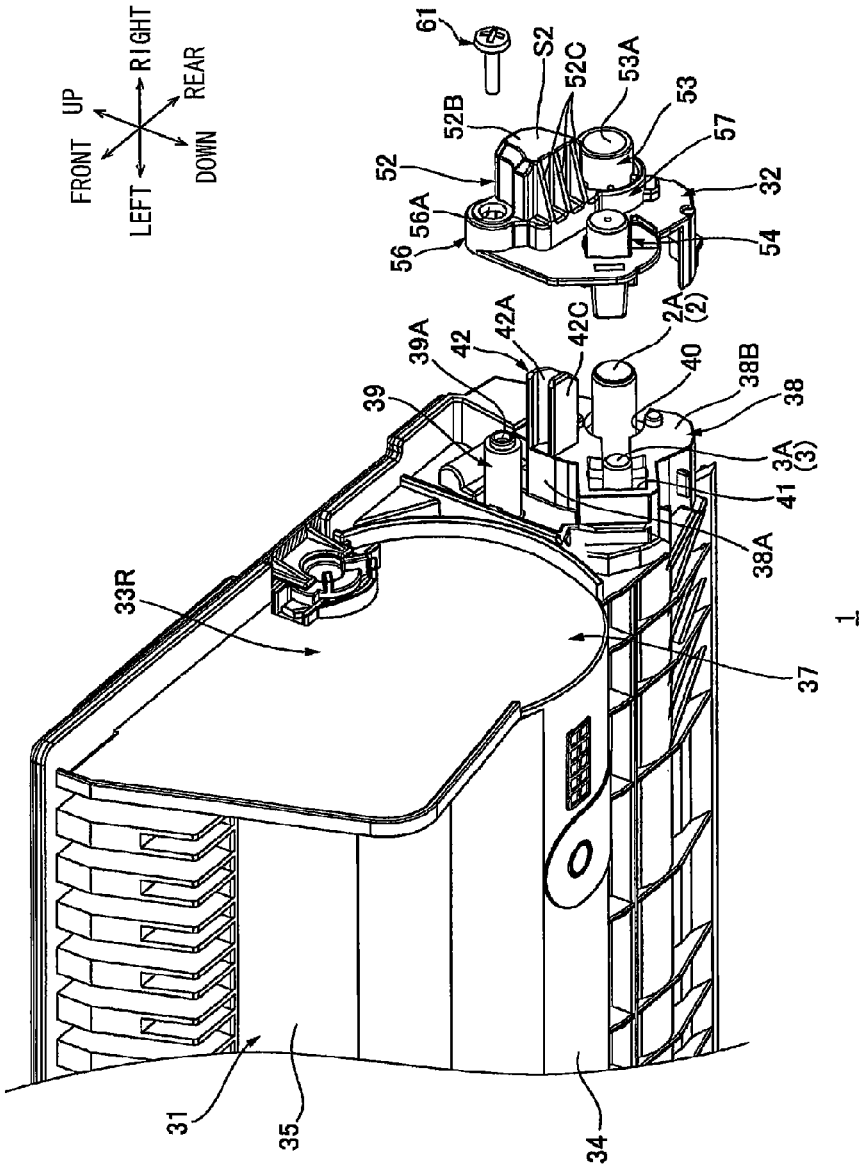
42
39
40
38
41
57
53
3A(3)
39A
42C
S1
52A
56
53A
54
S2
56A
32
52
52B
61
37
33R

FIG. 3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LEFT
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S2
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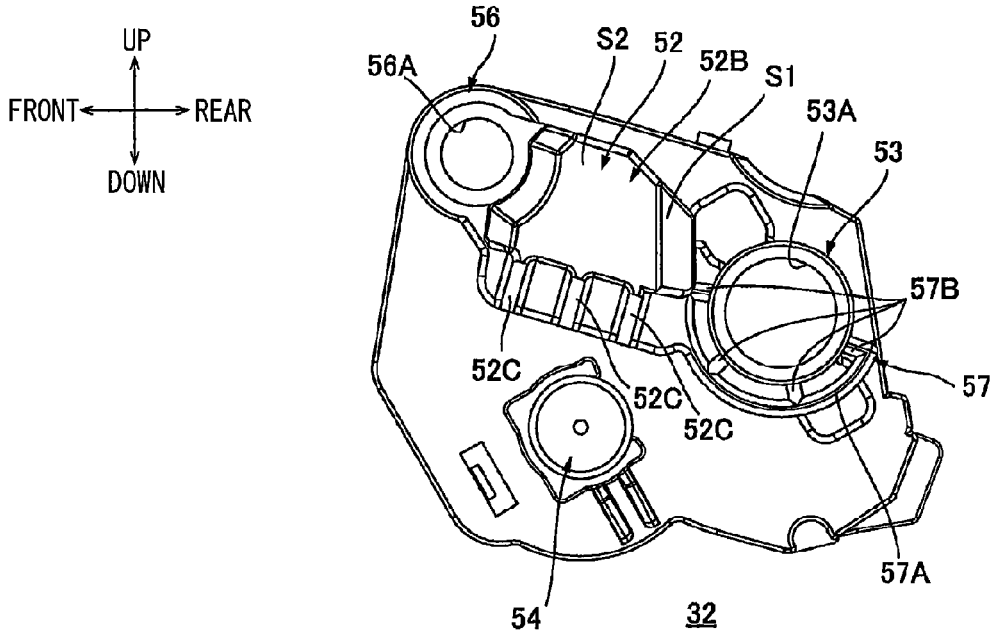
53A
53
52B
57
52
32
56A
54
56
2A
(2)
42C
42A
42
39A
40
38B
38
39
3A
(3)
41
38A
33R
37
1
31
35
34

FIG. 4

FIG. 5A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56A
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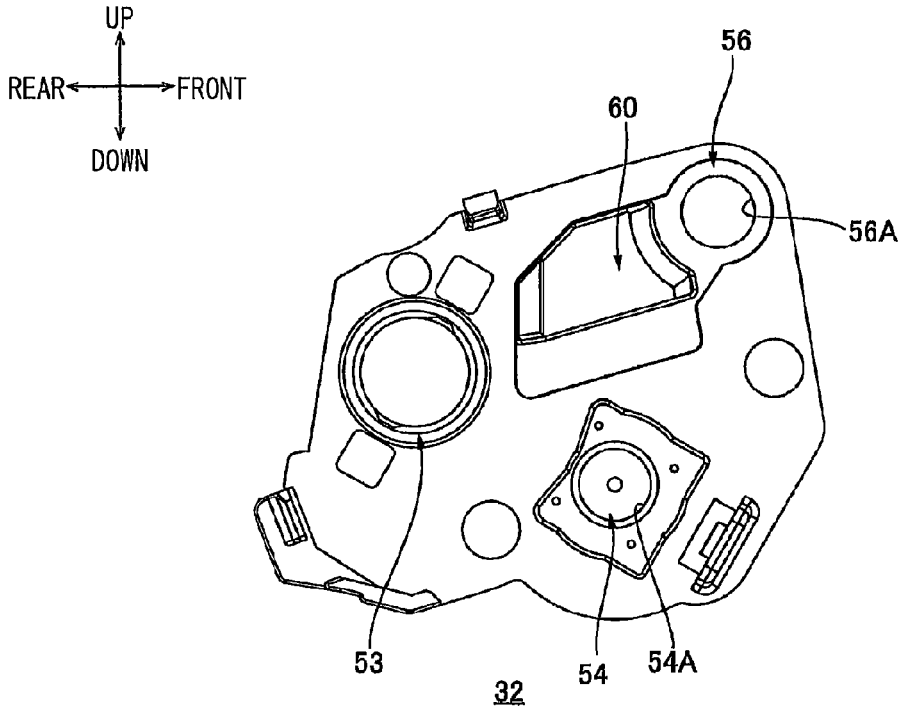
57
57A
54
32

FIG. 5B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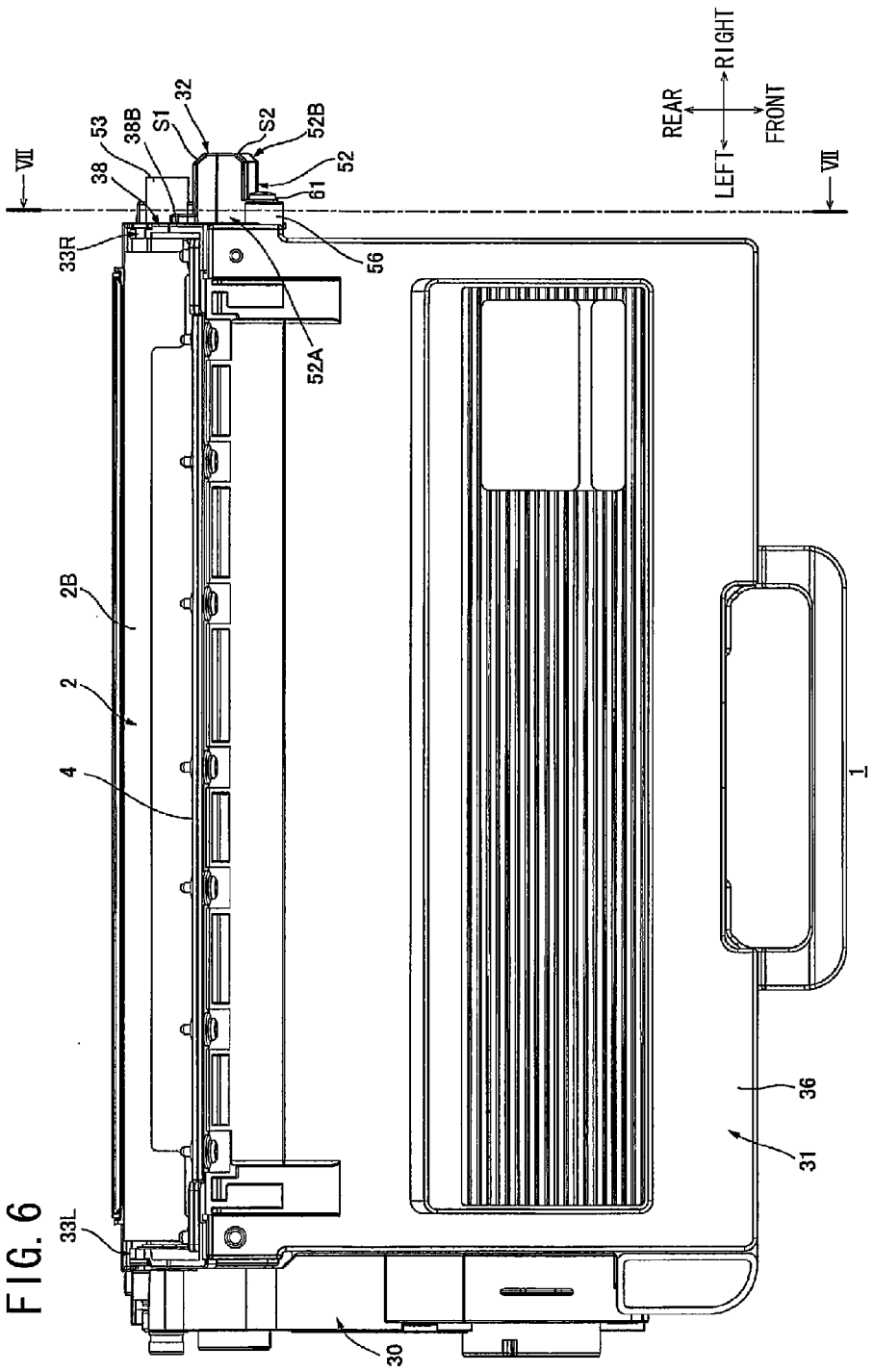
56A
53
54
54A
32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LEFT
VII
VII
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S1
S2
52B
53
38B
38
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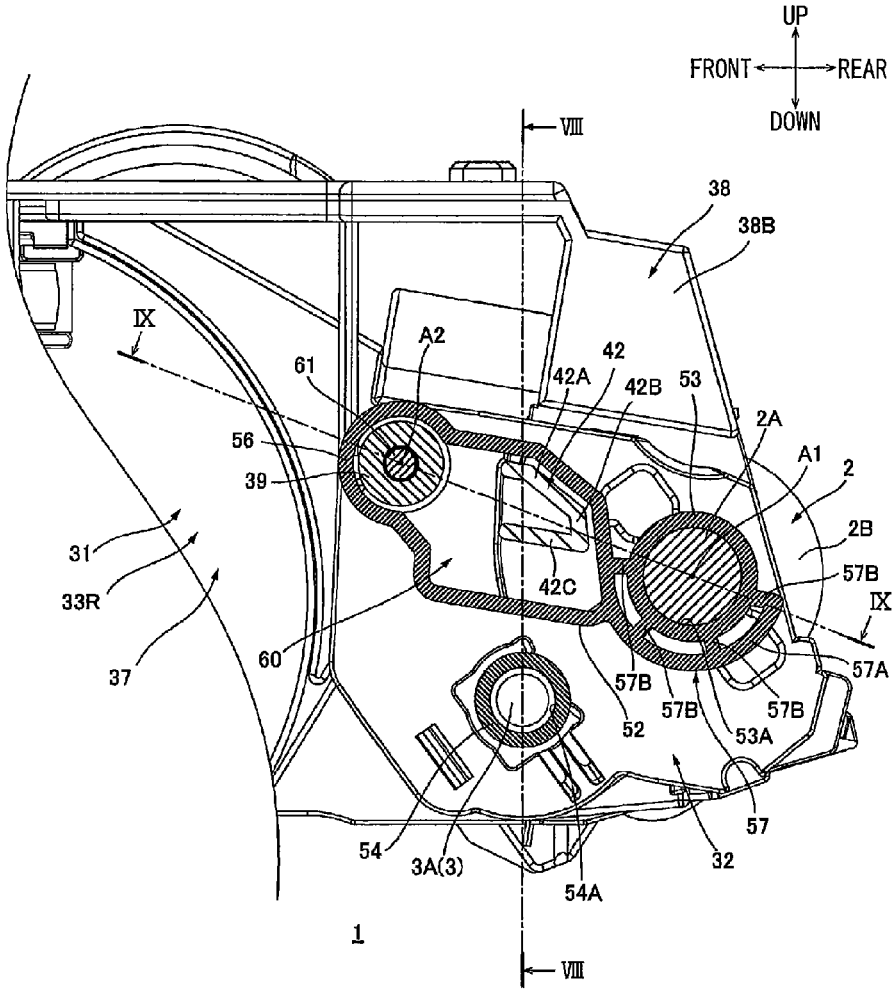
61
33R
56
52A
2B
2
4
1
36
31
33L
30

FIG. 6

FIG. 7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VIII
38
38B
IX
A2
61
42
42A
42B
53
2A
56
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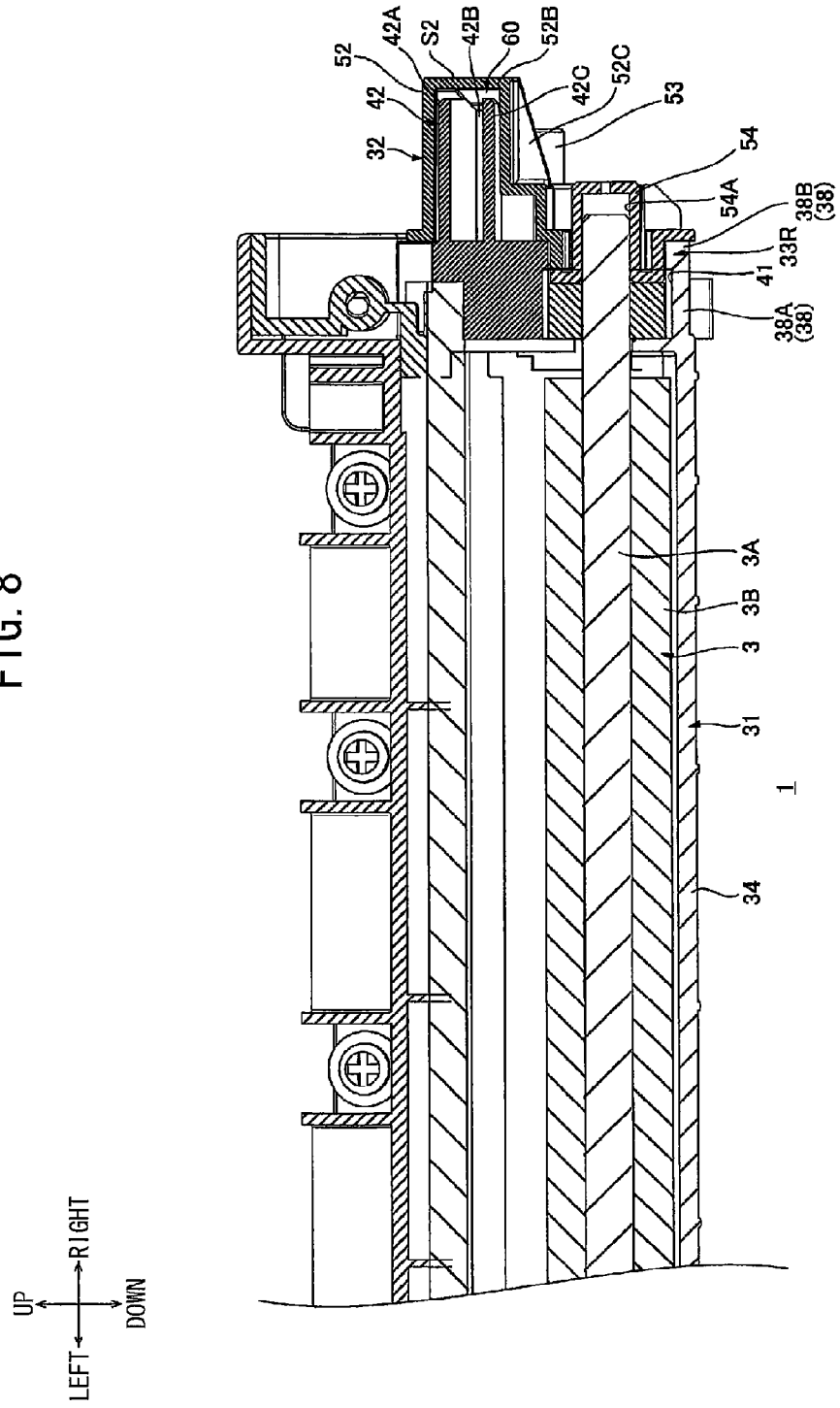
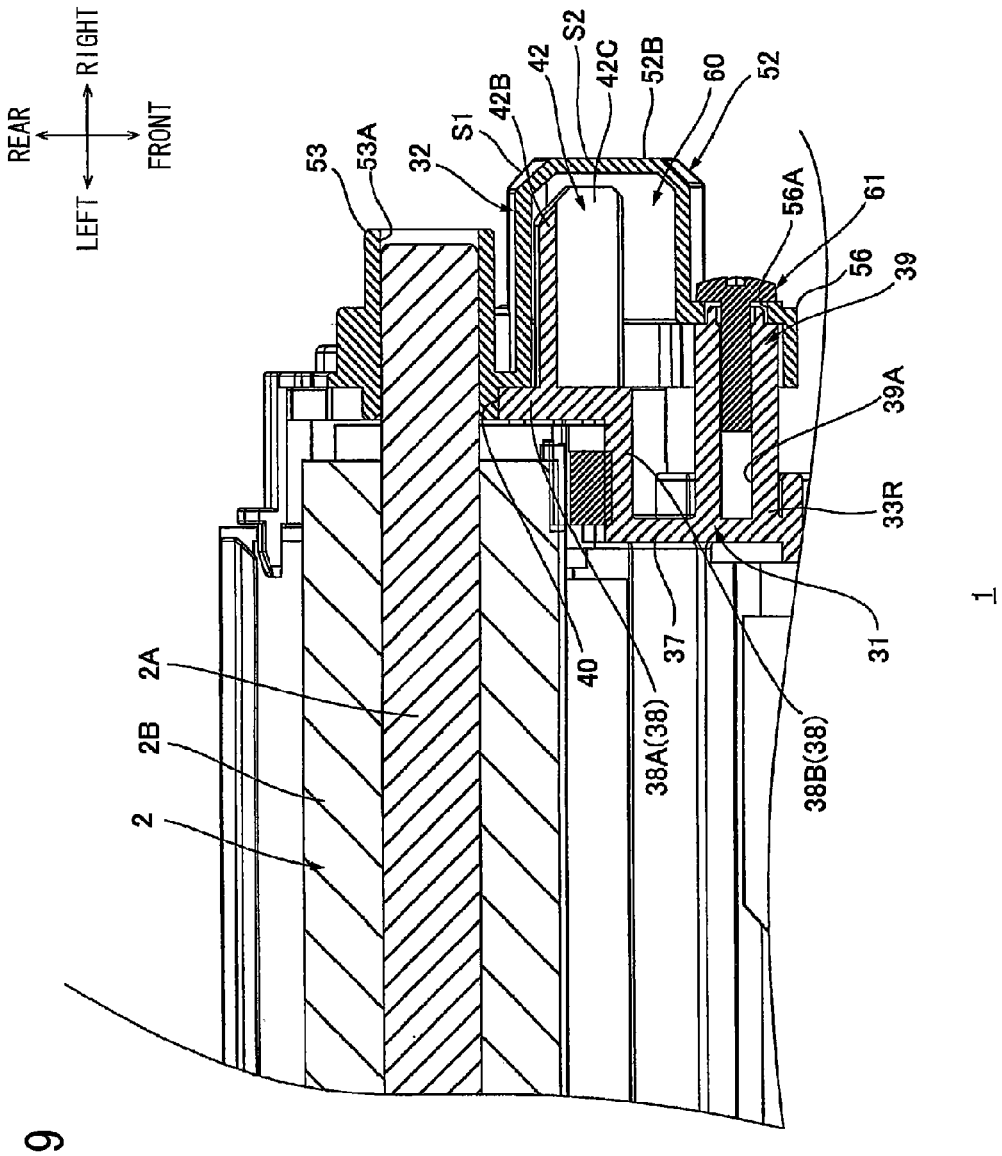
2
39
2B
31
57B
33R
42C
IX
37
60
57A
57B
57B
57B
52
53A
57
54
3A(3)
32
54A
1
VIII

FIG. 8


52
42A
S2
42B
60
52B
42
42C
52C
53
32
54
54A
38B
(38)
33R
41
38A
(38)
3A
3B
3
31
1
34
UP
RIGHT
LEFT
DOWN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RIGHT
LEFT
FRONT
53
53A
32
S1
42B
42
S2
42C
52B
60
52
56A
61
56
39
39A
33R
31
40
37
38A(38)
38B(38)
2A
2B
2
1

FIG. 9

FIG. 10A

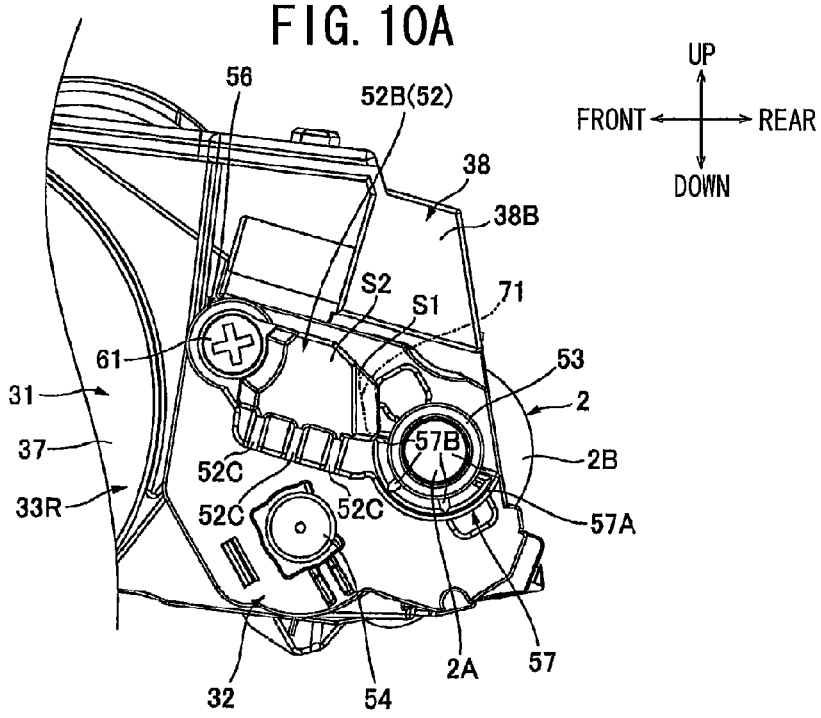
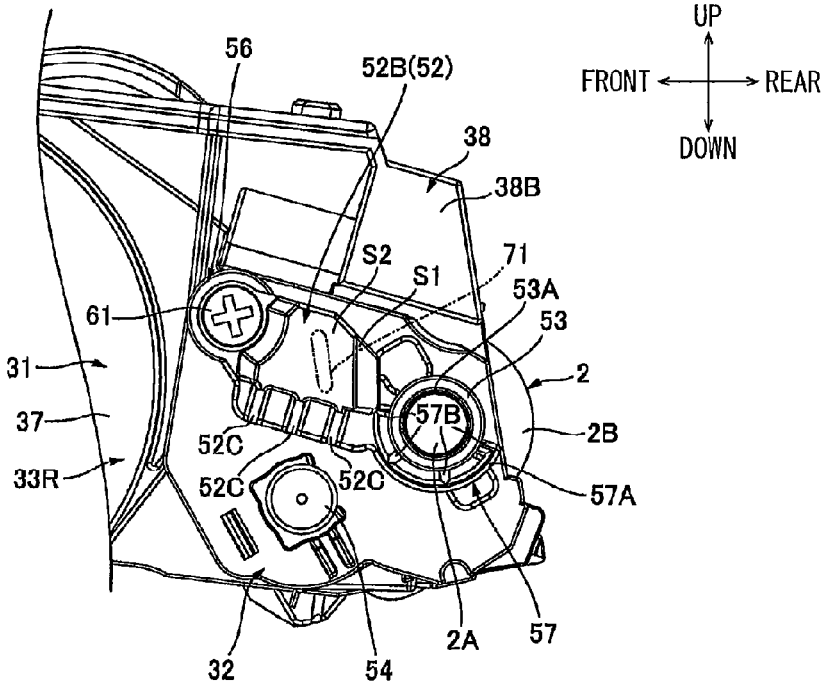


FIG. 10B



DEVELOPING CARTRIDGE INCLUDING ELECTRODE AND PROTRUSION

CROSS REFERENCE TO RELATED APPLICATION

This application claims priority from Japanese Patent Application No. 2015-017786 filed Jan. 30, 2015. The entire content of the priority application is incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to a developing cartridge to be assembled in an electro-photographic type image forming apparatus.

BACKGROUND

A developing cartridge attachable to an electro-photographic type image forming apparatus is known in the prior art. The prior art discloses a developing cartridge including a developing roller, and a developing electrode made from electro-conductive resin.

Upon attachment of the developing cartridge to an image forming apparatus, the developing electrode is in contact with an electrode at the image forming apparatus side. Thus, electric power can be supplied from the image forming apparatus to the developing roller through the developing electrode.

SUMMARY

According to the disclosed developing cartridge, the developing electrode protrudes outside in an axial direction of the developing roller because the developing electrode can be in contact with the electrode of apparatus side. Thus, high mechanical strength of the developing electrode is required on the ground that the developing cartridge may drop.

In view of the foregoing, it is therefore an object of the disclosure to provide a developing cartridge capable of providing an increased mechanical strength of the electrode.

In order to attain the above and other objects, the disclosure provides a developing cartridge may include a casing, a developing roller, a first protrusion, and an electrode. The casing may be configured to accommodate developer therein. The developing roller may include a developing roller shaft extending in a first direction. The first protrusion may be positioned at an outer surface of the casing. The first protrusion may protrude outward from the outer surface in the first direction. The electrode may be positioned at the outer surface. The electrode may be configured to be electrically connected to the developing roller shaft. The electrode may include a second protrusion protruding outward in the first direction. The second protrusion may have an inner space extending in the first direction. The inner space may be positioned in the second protrusion. The first protrusion may be positioned in the inner space.

The developing cartridge of the present disclosure can suppress breakage of an electrode.

BRIEF DESCRIPTION OF THE DRAWINGS

The particular features and advantages of the disclosure as well as other objects will become apparent from the following description taken in connection with the accompanying drawings, in which:

FIG. **1** is an example of a perspective view of a developing cartridge according to one embodiment;

FIG. **2** is an example of a schematic cross-sectional view of a center portion of an image forming apparatus in which the developing cartridge illustrated in FIG. **1** is assembled;

FIG. **3** is an example of a perspective view of the developing cartridge illustrated in FIG. **1** and showing a state where an electrode member is removed;

FIG. **4** is an example of an exploded perspective view of the developing cartridge illustrated in FIG. **3** and showing the state where the electrode member is removed;

FIG. **5**A is an example of a right side view of the electrode member illustrated in FIG. **3**;

FIG. **5**B is an example of a left side view of the electrode member illustrated in FIG. **3**;

FIG. **6** is an example of a plan view of the developing cartridge illustrated in FIG. **1**;

FIG. **7** is an example of a cross-sectional view of the developing cartridge taken along a line VII-VII in FIG. **6**;

FIG. **8** is an example of a cross-sectional view of the developing cartridge taken along a line VIII-VIII in FIG. **7**;

FIG. **9** is an example of a cross-sectional view of the developing cartridge taken along a line IX-IX in FIG. **7**;

FIG. **10**A is an example of a view for description of the developing cartridge partially assembled to a housing of the image forming apparatus, and showing a state where an electrode of the image forming apparatus is brought into contact with a rear end portion of the developing electrode; and

FIG. **10**B is an example of a view for description of the developing cartridge fully assembled to the housing of the image forming apparatus, and showing a state where the electrode of the image forming apparatus is in contact with a right surface of the developing electrode.

DETAILED DESCRIPTION

A developing cartridge according to one embodiment will be described with reference to FIGS. **1** to **10**B.

1. Outline of Developing Cartridge

As illustrated in FIGS. **1** and **2**, a developing cartridge **1** includes a casing **31**, a developing roller **2**, a supply roller **3**, and a layer thickness regulation blade **4**. Regarding directions in the following description, an extending direction of the developing roller **2** will be referred to as the "leftward/rightward direction", and the "upward/downward direction" referred herein is a direction when the developing cartridge **1** is oriented in a horizontal posture. Further, the "frontward/rearward direction" referred herein is a direction determined on the leftward/rightward direction and the upward/downward direction. These directions are exemplified in FIG. **1**.

The casing **31** has an internal space defined as a toner accommodating portion **5** configured to accommodate therein toner.

The developing roller **2** is positioned at a rear end portion of the developing cartridge **1** and is rotatably supported by the casing **31**. The developing roller **2** includes a developing roller shaft **2**A and a roller portion **2**B.

The developing roller shaft **2**A is cylindrical and extends in the leftward/rightward direction. The roller shaft **2**A is made of metal.

The roller portion **2**B is hollow cylindrical and extends in the leftward/rightward direction. The roller portion **2**B is made of an electrically conductive rubber. The roller portion **2**B covers a center of the roller shaft **2**A, while left and right end portions of the roller shaft **2**A are not covered with the roller portion **2**B. Incidentally, the roller portion **2**B is

positioned between a left wall **33**L (described later) and a right wall **33**R (described later) of the cartridge frame **31**. A portion of the roller portion **2**B is exposed to an outside through the cartridge frame **31**. The roller shaft **2**A penetrates through the roller portion **2**B in the leftward/rightward direction. Alternatively, the roller shaft **2**A may extend from both ends of the roller portion **2**B in the leftward/rightward direction, respectively.

The supply roller **3** is adapted to supply toner in the toner accommodating portion **5** to the developing roller **2**. The supply roller **3** is rotatably supported by the casing **31**, and is positioned between the developing roller **2** and the toner accommodating portion **5**. The supply roller **3** includes a supply roller shaft **3**A and a roller portion **3**B.

The supply roller shaft **3**A is cylindrical and extends in the leftward/rightward direction. The roller shaft **3**A is made of metal.

The roller portion **3**B is hollow cylindrical and extends in the leftward/rightward direction. The roller portion **3**B is made of an electrically conductive sponge. The roller portion **3**B covers a center of the roller shaft **3**A, while left and right end portions of the roller shaft **3**A are not covered with the roller portion **3**B. Incidentally, the roller portion **3**B is positioned between the left wall **33**L (described later) and the right wall **33**R (described later) of the cartridge frame **31**. A portion of the roller portion **2**B is exposed to an outside through the cartridge frame **31**. The roller portion **3**B is in contact with a surface of the roller portion **2**B of the developing roller **2**. The roller shaft **3**A penetrates through the roller portion **3**B in the leftward/rightward direction. Alternatively, the roller shaft **3**A may extend from both ends of the roller portion **3**B in the leftward/rightward direction, respectively.

The layer thickness regulation blade **4** is adapted to regulate a thickness of a toner layer formed on a surface of the roller portion **2**B. The layer thickness regulation blade **4** is in contact with the surface of the roller portion **2**B.

The toner accommodating portion **5** accommodates therein the agitator **6**. The agitator **6** extends in the leftward/rightward direction and is rotatably supported in the toner accommodating portion **5**.

2. Using Manner of Developing Cartridge

As illustrated in FIG. **2**, the developing cartridge **1** is installed in an image forming apparatus **11**. A combination of the developing cartridge **1** and a drum cartridge **21** constitute a process cartridge **10**.

The image forming apparatus **11** is an electro-photographic type monochromatic printer, and includes a housing **12**, a scanner unit **13**, and a fixing unit **14**.

The housing **12** is box shaped whose front end is formed with an opening **15**. The housing **12** includes a front cover **16**, a sheet tray **17**, and a discharge tray **18**. The process cartridge **10** can be attached to and detached from the housing **12** through the opening **15**.

The front cover **16** is provided at the front end portion of the housing **12** and is plate-shaped. The front cover **16** is configured to open and close the opening **15**. The sheet tray **17** is configured to accommodate sheets P.

The drum cartridge **21** includes a photosensitive drum **22**, a scorotron charger **23**, and a transfer roller **24**.

The photosensitive drum **22** is rotatably supported by a frame of the drum cartridge **21**. The photosensitive drum **22** has a cylindrical shape extending in the leftward/rightward direction.

The scorotron charger **23** is disposed above the photosensitive drum **22** and is spaced away therefrom.

The transfer roller **24** is positioned below the photosensitive drum **22** and is in contact with the surface of the photosensitive drum **22**.

The developing cartridge **1** is attached to the photosensitive drum **22** so that the roller portion **2**B of the developing roller **2** is in contact with the surface of the photosensitive drum **22**.

The scanner unit **13** is positioned above the process cartridge **10**, and is adapted to emit laser beam based on image data to the photosensitive drum **22**.

The fixing unit **14** is positioned rearward of the process cartridge **10**, and includes a heat roller **19** and a pressure roller **20**.

Upon start of the image forming operation in the image forming apparatus **11**, the peripheral surface of the photosensitive drum **22** is uniformly charged by the scorotron charger **23** and is exposed to light by the scanner unit **13**. Thus, an electrostatic latent image based on the image data is formed on the peripheral surface of the photosensitive drum **22**.

The agitator **6** agitates toner in the toner accommodating portion **5** and supplies toner to the supply roller **3**. The supply roller **3** supplies toner that has been supplied by the agitator **6** to the developing roller **2**. In this case, triboelectric charging is performed between the developing roller **2** and the supply roller **3** so that the toner is charged with positive polarity. The toner is then carried on the developing roller **2**. The layer thickness regulation blade **4** regulates thickness of a layer of the toner carried on the developing roller **2** into a uniform thickness.

The toner carried on the developing roller **2** is supplied to the electrostatic latent image on the peripheral surface of the photosensitive drum **22**. Thus a toner image is carried on the peripheral surface of the photosensitive drum **22**.

Each sheet P is supplied from the sheet tray **17** to a position between the photosensitive drum **22** and the transfer roller **24** at a prescribed timing by the rotation of rollers. Toner image carried on the peripheral surface of the photosensitive drum **22** is transferred onto the sheet P when the sheet P passes through a position between the photosensitive drum **22** and the transfer roller **24**.

Thereafter, the sheet P is heated and pressed when the sheet P passes through a position between the heat roller **19** and the pressure roller **20**. Thus, the toner image on the sheet P is thermally fixed to the sheet P. Then, the sheet P is discharged onto the discharge tray **18**.

3. Details of Developing Cartridge

As illustrated in FIG. **3**, the developing cartridge **1** includes the casing **31**, a developing electrode **32**, and a drive unit **30**. In the embodiment, the position of the toner accommodating portion **5** relative to the casing **31** is defined as an inner position. Further, the position opposite to the inner position (the position of the toner accommodating portion **5** relative to the casing **31**) is defined as an outer position. Further, an exposed surface of the casing **31** will be referred to as an outer surface of the casing **31**.

(1) Casing

As illustrated in FIGS. **3** and **4**, the casing **31** has a box shape. The casing **31** includes the toner accommodating portion **5** (FIG. **2**). The casing **31** supports the developing roller **2** (FIG. **2**), the supply roller **3**, and the layer thickness regulation blade **4**. The casing **31** includes the right wall **33**R, the left wall **33**L, a lower wall **34**, a front wall **35**, and an upper wall **36**. A space surrounded by the left wall **33**L, the right wall **33**R, the lower wall **34**, the front wall **35**, and the upper wall **36** is defined as the toner accommodating portion **5**.

The right wall **33**R is positioned at the right end portion of the casing **31**. Specifically, the right wall **33**R is disposed at a position corresponding to one end portion (right end portion) of the developing roller **2** in the leftward/rightward direction. Further, the left wall **33**L is positioned at a position corresponding to the other end portion (left end portion) of the developing roller **2** in the leftward/rightward direction. The other end portion is separated from the one end portion of the developing roller **2** and is positioned at the opposite side of the developing roller **2** from the one end portion in the leftward/rightward direction. The right wall **33**R has a rectangular plate shape which extends in the frontward/rearward direction and the upward/downward direction. The right wall **33**R includes a first right wall **37** and a second right wall **38**.

The first right wall **37** constitutes the main part of the right wall **33**R in the frontward/rearward direction. The first right wall **37** has a rectangular plate shape which extends in the frontward/rearward direction and the upward/downward direction. The first right wall **37** includes a protrusion **39**. The protrusion **39** has a columnar shape and extends outward from the outer surface of the first right wall **37**. The protrusion **39** has a screw hole **39**A. The screw hole **39**A is a circular hole recessed leftward from the right surface of the protrusion **39**.

The second right wall **38** is disposed at a position corresponding to the right end portion of the developing roller **2** in the leftward/rightward direction. The second right wall **38** includes a wall **38**A and a wall **38**B.

The wall **38**A has a plate shape which extends from the first right wall **37** in the leftward/rightward direction.

The wall **38**B has a plate shape which extends from the right end of the wall **38**A in the frontward/rearward direction. The wall **38**B includes an insertion hole **40**, an insertion hole **41** and a reinforcement protrusion **42**.

The insertion hole **40** is positioned at the rear end portion of the wall **38**B and penetrates the wall **38**B in the leftward/rightward direction. The insertion hole **40** is a hole having a substantial circular shape. The right end portion of the developing roller shaft **2**A is inserted into the insertion hole **40** with a play.

The insertion hole **41** is positioned at the front lower side of the insertion hole **40**. The insertion hole **41** is a rectangular hole and penetrates the wall **38**B in the leftward/rightward direction. The right end portion of the supply roller shaft **3**A is inserted into the insertion hole **41** with a play.

As illustrated in FIGS. **3** and **7**, the reinforcement protrusion **42** is positioned between the protrusion **39** and the insertion hole **40** in the frontward/rearward direction. The reinforcement protrusion **42** protrudes outward from the outer surface of the wall **38**B. The length of the reinforcement protrusion **42** from the outer surface of the wall **38**B in the leftward/rightward direction is preferably 15.4 mm. The length of the reinforcement protrusion **42** from the outer surface of the wall **38**B in the leftward/rightward direction may be no shorter than 14.4 mm and no longer than 16.4 mm. Further, the length of the reinforcement protrusion **42** in the upward/downward direction is preferably 5.9 min. The length of the reinforcement protrusion **42** in the upward/downward direction may be no shorter than 5.4 mm and no longer than 6.4 mm. The reinforcement protrusion **42** has a U-shape when viewed in the leftward/rightward direction.

The protrusion **39** is positioned at the opposite side of the developing roller shaft **2**A with respect to the reinforcement protrusion **42**. Specifically, the reinforcement protrusion **42** includes an upper reinforcement portion **42**A, a rear reinforcement portion **42**B, and a lower reinforcement portion **42**C.

The upper reinforcement portion **42**A is positioned at the upper end portion of the reinforcement protrusion **42**. The upper reinforcement portion **42**A has a plate shape which extends in the frontward/rearward direction. The length of the upper reinforcement portion **42**A in the frontward/rearward direction is 5 mm, preferably. The length of the upper reinforcement portion **42**A in the frontward/rearward direction may be no shorter than 4.5 mm and no longer than 5.5 mm.

The rear reinforcement portion **42**B is positioned at the rear end portion of the reinforcement protrusion **42**. The rear reinforcement portion **42**B has a plate shape which extends in the upward/downward direction. Preferably, the length of the rear reinforcement portion **42**B in the frontward/rearward direction is 2 mm. Further, the length of the rear reinforcement portion **42**B in the frontward/rearward direction may be no shorter than 1.5 mm and no longer than 2.5 mm.

The lower reinforcement portion **42**C is positioned at the lower end portion of the reinforcement protrusion **42**. The lower reinforcement portion **42**C has a plate shape which extends in the frontward/rearward direction. The length of the lower reinforcement portion **42**C in the frontward/rearward direction is 6.0 mm, preferably. Further, the length of the lower reinforcement portion **42**C in the frontward/rearward direction may be no shorter than 5.5 mm and no longer than 6.5 mm.

As illustrated in FIG. **3**, the left wall **33**L is located at the left end portion of the casing **31**. The left wall **33**L has a rectangular plate shape which extends in the frontward/rearward direction and the upward/downward direction. Similarly to the right wall **33**R, the left wall **33**L has an insertion hole (not illustrated) through which the left end portion of the developing roller shaft **2**A is inserted, and an insertion hole (not illustrated) through which the left end portion of the supply roller shaft **3**A is inserted.

As illustrated in FIG. **4**, the lower wall **34** has a plate shape which extends in the frontward/rearward direction. The lower wall **34** is connected to the right wall **33**R and the left wall **33**L.

The front wall **35** has a plate shape which extends upward from the front end portion of the lower wall **34** and is connected to the front end portion of the lower wall **34**. The front wall **35** is further connected to the right wall **33**R and the left wall **33**L.

The upper wall **36** has a rectangular plate shape. The upper wall **36** is fixed to the front wall **35**, the left wall **33**L, and the right wall **33**R.

(2) Developing Electrode

(2-1) Configuration of Developing Electrode

As illustrated in FIGS. **1**, **3**, and **4**, the developing electrode **32** is attached to the outer surface of the casing **31**. Specifically, the developing electrode **32** is attached to the rear end portion of the outer surface of the right wall **33**R. The developing electrode **32** is positioned between the developing roller **2** and the agitator **6** (FIG. **2**) in the frontward/rearward direction. The developing electrode **32** is made of a conductive resin. The developing electrode **32** includes a developing roller bearing **53**, a supply roller bearing **54**, a protrusion **52**, and a reinforcement portion **57**. As illustrated in FIG. **1**, the protrusion **52** of the developing electrode **32** protrudes outward from the right wall **33**R when the developing electrode **32** is attached to the outer surface of the right wall **33**R.

As illustrated in FIGS. **4**, **5**A, and **5**B, the developing roller bearing **53** has a cylindrical shape which extends from the developing electrode **32** in the leftward/rightward direction. The cylindrical shape extending in the leftward/rightward direction is preferably 12.1 mm. Further, the length of the cylindrical shape extending in the leftward/rightward direction may be no shorter than 11.9 mm and no longer than 12.3 mm.

The developing roller bearing **53** has an insertion hole **53**A into which the right end portion of the developing roller shaft **2**A is rotatably fitted. When the peripheral surface of the right end portion of the developing roller shaft **2**A contacts the developing roller bearing **53**, the developing electrode **32** is electrically connected to the developing roller shaft **2**A. Further, the insertion hole **53**A of the developing roller bearing **53** may be different from a through hole, as long as the insertion hole **53**A is a hole into which the right end portion of the developing roller shaft **2**A is rotatably fitted. The diameter of the insertion hole **53**A is 7.55 mm, preferably. Further, the diameter of the insertion hole **53**A may be no shorter than 7.52 mm and no longer than 7.58 mm.

As illustrated in FIGS. **4**, **5**A, and **5**B, the supply roller bearing **54** has a cylindrical shape which extends from the developing electrode **32** in the leftward/rightward direction. Preferably, the length of the cylindrical shape extending in the leftward/rightward direction of the supply roller bearing **54** is 6.3 mm. Further, the length of the cylindrical shape extending in the leftward/rightward direction of the supply roller bearing **54** may be no shorter than 6.1 mm and no longer than 6.5 mm. The right end of the supply roller bearing **54** is closed. The supply roller bearing **54** includes an insertion hole **54**A into which the right end portion of the supply roller shaft **3**A is rotatably fitted. When the peripheral surface of the right end portion of the supply roller shaft **3**A contacts the supply roller bearing **54**, the developing electrode **32** is electrically connected to the supply roller shaft **3**A.

Further, the insertion hole **54**A of the supply roller bearing **54** may be a through hole, as long as the insertion hole **54**A is a hole into which the right end portion of the supply roller shaft **3**A is rotatably fitted. The diameter of the insertion hole **54**A is 5.05 mm, preferably. Further, the diameter of the insertion hole **54**A may have a size equal to or larger than 5.02 mm and equal to or smaller than 5.08 mm.

In this way, the developing electrode **32** serves as bearings for supporting the developing roller shaft **2**A and the supply roller shaft **3**A.

As illustrated in FIGS. **4** and **5**A, the protrusion **52** protrudes outward in the leftward/rightward direction. The protrusion **52** has a prismatic shape which extends in the leftward/rightward direction. Preferably, the projection amount of the protrusion **52** is 17.6 mm. Further, the protrusion amount of the protrusion **52** may be no shorter than 15.6 mm and no longer than 19.6 mm. The protrusion **52** includes an upper end surface **52**A (FIGS. **1** and **3**), a right end surface **52**B, a reinforcement rib **52**C, and a fixed portion **56**.

The upper end surface **52**A is the upper portion of the protrusion **52**. The upper end surface **52**A extends in the leftward/rightward direction.

The right end surface **52**B is the right end portion of the protrusion **52**. The right end surface **52**B is a surface which extends in the frontward/rearward direction. The right end surface **52**B includes a first surface S**1** and a second surface S**2**.

The second surface S**2** is a surface which extends in the leftward/rightward direction. In the embodiment, the second surface S**2** extends in parallel to the right wall **33**R as shown in FIG. **6**. The second surface S**2** is farther from the right wall **33**R than the developing roller bearing **53** in the leftward/rightward direction.

As illustrated in FIGS. **5**A and **5**B, the first surface S**1** is positioned between the developing roller bearing **53** and the second surface S**2** in the frontward/rearward direction. In other words, as illustrated in FIG. **1**, the first surface S**1** is positioned between the developing roller **2** and the second surface S**2** in the frontward/rearward direction. Further, the first surface S**1** is connected to the second surface S**2**. The first surface S**1** is an inclined surface such that the larger the distance from the right wall **33**R is, the closer to the second surface S**2** a part of the first surface S**1** is.

The plurality of reinforcement ribs **52**C includes ribs each reinforcing the protrusion **52**. As shown in FIG. **4**, each reinforcement rib **52**C is positioned at the lower surface of the protrusion **52** and extends in the leftward/rightward direction. The plurality of the reinforcement ribs **52**C is disposed with a gap therebetween in the frontward/rearward direction. Specifically, three reinforcement ribs **52**C are disposed with a gap therebetween in the frontward/rearward direction. Each reinforcement rib **52**C protrudes downward from the lower surface of the protrusion **52**. The length of each reinforcement rib **52**C in the upward/downward direction is shortened as the distance from the right wall **33**R increases.

As illustrated in FIG. **5**B, the protrusion **52** has a space **60** therein. The space **60** extends in the leftward/rightward direction. The space **60** is defined by an inner surface of the protrusion **52**. The reinforcement protrusion **42** is positioned in the space **60**. Specifically, the reinforcement protrusion **42** is inserted into the space **60** and is positioned inside the protrusion **52**. The space **60** has a size so that the reinforcement protrusion **42** is insertable. Preferably, the length of the space **60** in the leftward/rightward direction is 16.5 mm. Further, the length of the space **60** in the leftward/rightward direction may be no shorter than 15.5 mm and no longer than 17.5 mm.

As illustrated in FIGS. **4** and **5**B, the fixed portion **56** has a cylindrical shape which extends in the leftward/rightward direction. Preferably, the length of the cylindrical shape extending in the leftward/rightward direction of the fixed portion **56** is 6.6 mm. Further, the length of the cylindrical shape extending in the leftward/rightward direction of the fixed portion **56** may be no shorter than 6.4 mm and no longer than 6.8 mm. The protrusion **52** includes one end portion and other end portion further from the developing roller shaft **2**A than the one end portion of the protrusion, and the fixed portion **56** is provided on the other portion of the protrusion **52**. The other end portion of the protrusion **52** is farther from the developing roller shaft **2**A than the one end portion of the protrusion **52** in the front/read direction. The one end portion of the protrusion **52** is positioned closer to the developing roller shaft **2**A in the frontward/rearward direction than the other end portion of the protrusion **52**. The fixed portion **56** has a screw insertion hole **56**A into which the right end portion of the protrusion **39** is insertable. The screw insertion hole **56**A has a size so that the right end portion of the protrusion **39** is insertable.

The screw insertion hole **56**A penetrates the fixed portion **56** in the leftward/rightward direction. The screw insertion hole **56**A is a circular hole. The diameter of the screw insertion hole **56**A is preferably 4.98 mm. Further, the

diameter of the screw insertion hole **56**A may be no shorter than 4.97 mm and no longer than 4.99 mm.

As illustrated in FIGS. **4** and **5**A, the reinforcement portion **57** is positioned below the developing roller bearing **53**. The reinforcement portion **57** includes a surrounding portion **57**A and a plurality of connection portions **57**B.

The surrounding portion **57**A extends in the leftward/rightward direction so as to surround the developing roller bearing **53**. The surrounding portion **57**A is curved along the peripheral surface of the developing roller bearing **53**.

The connection portions **57**B are positioned between the surrounding portion **57**A and the developing roller bearing **53**. Specifically, four connection portions **57**B are disposed in the circumferential direction of the developing roller bearing **53** with a gap between two adjacent connection portions **57**B. Each connection portion **57**B connects the surrounding portion **57**A and the developing roller bearing **53**.

(2-2) Attachment of Developing Electrode

As illustrated in FIGS. **1** and **6**, the developing electrode **32** is attached to the outer surface of the right wall **33**R of the casing **31** by a screw **61**.

Specifically, when the developing electrode **32** is attached to the outer surface of the right wall **33**R, the right end portion of the developing roller shaft **2**A is rotatably fitted into the insertion hole **53**A of the developing roller bearing **53** as illustrated in FIG. **7**. When the surface of the right end portion of the developing roller shaft **2**A contacts the developing roller bearing **53**, the developing electrode **32** is electrically connected to the developing roller shaft **2**A.

The right end portion of the supply roller shaft **3**A is rotatably fitted into the insertion hole **54**A of the supply roller bearing **54**. When the surface of the right end portion of the supply roller shaft **3**A contacts the supply roller bearing **54**, the developing electrode **32** is electrically connected to the supply roller shaft **3**A.

As illustrated in FIGS. **7** and **8**, the reinforcement protrusion **42** is positioned inside the space **60**. Specifically, as illustrated in FIG. **7**, the reinforcement protrusion **42** is positioned in a part of the space **60** corresponding to the one end portion of the protrusion **52**, and the one end portion of the protrusion **52** is closer to the developing roller shaft **2**A than the other end portion of the protrusion **52**. In other words, the reinforcement protrusion **42** is not positioned in the other part of the space **60** corresponding to the other end portion of the protrusion **52**, and the other end portion of the protrusion **52** is farther from the developing roller shaft **2**A than the one end portion of the protrusion **52**. Specifically, the upper reinforcement portion **42**A of the reinforcement protrusion **42** extends along the inner surface of the upper portion of the protrusion **52**. The rear reinforcement portion **42**B of the reinforcement protrusion **42** extends along the inner surface of the rear end portion of the protrusion **52**. The lower reinforcement portion **42**C of the reinforcement protrusion **42** extends along the inner surface of the lower end portion of the right end surface **52**B of the protrusion **52**.

As illustrated in FIGS. **8** and **9**, the right end of the reinforcement protrusion **42** is farther from the right wall **33**R than the right end of the developing roller shaft **2**A. In other words, the right end of the reinforcement protrusion **42** is disposed outside the right end of the developing roller **2**A in the left/right direction.

As illustrated in FIGS. **7** to **9**, the right end portion of the protrusion **39** is positioned inside the screw hole **56**A of the fixed portion **56**. That is, the right end portion of the protrusion **39** is inserted into the screw hole **56**A of the fixed portion **56** in the leftward/rightward direction. Then, the fixed portion **56** is fixed to the protrusion **39** when the screw **61** is inserted into the screw insertion hole **56**A.

Further, as illustrated in FIGS. **1** and **7**, the protrusion **52** of the developing electrode **32** is positioned between the axis **A1** of the developing roller shaft **2**A and the axis **A2** of the screw **61** in the frontward/rearward direction.

(3) Drive Portion

As illustrated in FIG. **1**, the drive unit **30** is positioned at the outer surface of the left wall **33**L. The drive unit **30** includes, for example, a gear train including a plurality of gears. The gear train (not shown) includes a gear which rotates the developing roller shaft **2**A. Further, the gear train (not shown) further includes a gear which rotates the supply roller shaft **3**A.

4. Attachment of Developing Cartridge to Housing

When the developing cartridge **1** is attached to the housing **12**, the developing cartridge **1** is attached to the drum cartridge **21** and the developer cartridge **1** is inserted into the housing **12** in a state where the developer cartridge **1** is attached to the drum cartridge **21**.

When the developing cartridge **1** is inserted into the housing **12**, an electrode **71** provided inside the housing **12** contacts the first surface **S1** of the protrusion **52** as illustrated in FIG. **10**A. Then, the electrode **71** slides on the first surface **S1** and is guided along the first surface **S1** toward the second surface **S2**.

When the developing cartridge **1** is further inserted into the housing **12**, the electrode **71** contacts the second surface **S2** of the protrusion **52** as illustrated in FIG. **10**B. Then, the attachment of the developing cartridge **1** to the housing **12** is completed. Accordingly, the developing electrode **32** can receive the electric power via the electrode **71**.

5. Correspondence Relationships

The toner is an example of developer. The outer surface of the right wall **33**R is an example of an outer surface of the casing. The leftward/rightward direction is an example of a first direction. The reinforcement protrusion **42** is an example of a first protrusion. The developing electrode **32** is an example of an electrode. The protrusion **52** is an example of a second protrusion. The space **60** is an example of a space. The one end portion of the protrusion **52** is an example of a first end portion. The fixed portion **56** is an example of a second end portion. The frontward/rearward direction is an example of a second direction crossing the first direction. The protrusion **39** is an example of a third protrusion. The screw **61** is an example of a fixing member. The screw hole **56**A is an example of a through hole. The right end surface **52**B is an example of a portion of the second protrusion between an axis of the developing roller shaft and an axis of the screw. The first right wall **37** is an example of a first surface. The second right wall **38** is an example of a second surface. The right end of the reinforcement protrusion **42** is an example of an outer end of the first protrusion. The right end of the protrusion **52** is an example of an outer end of the second protrusion. The roller portion **2**B is an example of a roller member. The right wall **33**R is an example of a first wall. The left wall **33**L is an example of a second wall. The right surface of the right wall **33**R is an example of an outer surface of the first wall. The image forming apparatus **11** is an example of an image forming apparatus. The electrode **71** is an example of an electrical contact. The developing roller bearing **53** is an example of a bearing. The supply roller bearing **54** is an example of a bearing.

6. Effects

(1) According to the developing cartridge **1**, as illustrated in FIGS. **7** and **9**, the reinforcement protrusion **42** positioned

at the outer surface of the right wall **33**R of the casing **31** is positioned inside the space **60** defined by the right end surface **52**B of the developing electrode **32**. With this construction, the protrusion **52** of the developing electrode **32** can be reinforced by the reinforcement protrusion **42**.

(2) According to the developing cartridge **1**, the reinforcement protrusion **42** extends from the outer surface of the right wall **33**R of the casing **31** as illustrated in FIG. **3**. Since the reinforcement protrusion **42** extends from the outer surface of the right wall **33**R, the rigidity of the reinforcement protrusion **42** can be improved. As a result, the protrusion **52** of the developing electrode **32** can be further reinforced.

(3) According to the developing cartridge **1**, the developing electrode **32** is configured to be electrically connected to the supply roller shaft **3**A at the supply roller bearing **54** as illustrated in FIG. **7**. With this construction, electric power can be supplied to both the developing roller **2** and the supply roller **3** via the developing electrode **32**, and the protrusion **52** of the developing electrode **32** can be reinforced by the reinforcement protrusion **42**.

(4) According to the developing cartridge **1**, the reinforcement protrusion **42** is positioned at one end portion of the protrusion **52** near the developing roller shaft **2**A, as illustrated in FIG. **9**. With this construction, the one end portion of the protrusion **52** closer to the developing roller shaft **2**A can be reliably reinforced.

(5) According to the developing cartridge **1**, the fixed portion **56** of the protrusion **52** is fixed to the protrusion **39** by the screw **61** as illustrated in FIGS. **9** and **10**A. Accordingly, the other end portion of the protrusion **52** farther from the developing roller shaft **2**A than the one end portion of the protrusion **52** in the frontward/rearward direction can be reinforced by the fixed portion **56**, the screw **61**, and the protrusion **39**.

(6) According to the developing cartridge **1**, the protrusion **52** has a portion positioned between the axis A**1** of the developing roller shaft **2**A and the axis A**2** of the screw **61** in the frontward/rearward direction, as illustrated in FIGS. **7** and **10**A. With this configuration, the developing roller shaft **2**A and the screw **61** can protect the front portion and the rear portion of the protrusion **52**.

(7) According to the developing cartridge **1**, as illustrated in FIG. **7**, the developing electrode **32** includes the developing roller bearing **53** supporting the developing roller shaft **2**A, and the supply roller bearing **54** supporting the supply roller shaft **3**A. With this construction, the developing electrode **32** can supply the electrical power to the developing roller shaft **2**A and the supply roller shaft **3**A while bearing the developing roller shaft **2**A and the supply roller shaft **3**A.

Accordingly, the configuration of the developing cartridge **1** can be simplified without separately providing other bearings for supporting the developing roller shaft **2**A and the supply roller shaft **3**A.

(8) According to the developing cartridge **1**, as illustrated in FIGS. **3** and **4**, the reinforcement protrusion **42** protrudes from the right surface of the wall **38**B and the protrusion **39** protrudes from the outer surface of the first right wall **37**. With this configuration, the reinforcement protrusion **42** and the protrusion **39** can be provided in different walls.

(9) According to the developing cartridge **1**, as illustrated in FIG. **9**, the right end portion of the reinforcement protrusion **42** is farther from the outer surface of the right wall **33**R than the right end portion of the developing roller shaft **2**A is. Accordingly, the protrusion **52** of the developing electrode **32** can be reliably reinforced by the reinforcement protrusion **42**.

(10) According to the developing cartridge **1**, the developing electrode **32** is made of a conductive resin. Therefore, the developing electrode **32** can be easily molded by a conductive resin.

(11) According to the developing cartridge **1**, as illustrated in FIG. **10**A, the developing electrode **32** is attached to the outer surface of the right wall **33**R of the casing **31** by the screw **61**. With this construction, the developing electrode **32** can be attached to the outer surface of the casing **31** with a simple configuration.

(12) According to the developing cartridge **1**, as illustrated in FIG. **10**B, the protrusion **52** of the developing electrode **32** contacts the electrode **71** of the image forming apparatus **11** when the developing cartridge **1** is attached to the image forming apparatus **11**. With this construction, the electric power can be supplied from the image forming apparatus **11** to the developing roller **2** and the supply roller **3** via the developing electrode **32**.

7. Modifications and Variations

In the above described embodiment, the reinforcement protrusion **42** extends from the outer surface of the right wall **33**R, but the embodiment is not limited thereto. For example, a reinforcement protrusion may be positioned in the space **60** and extend along the space **60**. Further, a reinforcement protrusion extending along the space **60** may be attached to the outer surface of the right wall **33**R.

Further, in the embodiment, the developing roller shaft **2**A is directly connected to the developing roller bearing **53**, but the embodiment is not limited thereto, as long as the developing roller shaft **2**A and the developing roller bearing **53** can be electrically connected to each other. The developing roller shaft **2**A may be indirectly connected to the developing roller bearing **53**. For example, the developing roller shaft **2**A may be electrically connected to the developing roller bearing **53** via a conductive metal member. Further, the developing roller shaft **2**A may be electrically connected to the developing electrode **32** via a conductive metal member.

Further, in the embodiment, the supply roller shaft **3**A is directly connected to the supply roller bearing **54**, but the embodiment is not limited thereto, as long as the supply roller shaft **4**A and the supply roller bearing **54** can be electrically connected to each other. The supply roller shaft **3**A and the supply roller bearing **54** may be indirectly connected to each other. For example, the supply roller shaft **3**A and the supply roller bearing **54** may be electrically connected to each other via a conductive metal member. Further, the supply roller shaft **3**A may be electrically connected to the developing electrode **32** via a conductive metal member.

Further, in the embodiment, as illustrated in FIGS. **7** and **8**, the reinforcement protrusion **42** is positioned inside the space **60** of the protrusion **52**. Specifically, as shown in FIG. **7**, the reinforcement protrusion **42** is positioned in one end portion of the protrusion **52** near the developing roller shaft **2**A, but is not positioned in the other end portion of the protrusion **52** separated from the developing roller shaft **2**A. At least a part of the reinforcement protrusion **42** may be positioned at the other end portion of the protrusion **52** separated from the developing roller shaft **2**A.

In the above-described embodiment, the developing electrode **32** is attached to the casing **31** by the screw **61**, but the method of attaching the developing electrode **32** to the casing **31** is not particularly limited. For example, the

developing electrode **32** can be attached to the casing **31** by a method such as welding. In that case, the welded portion is an example of the fixed portion.

While the disclosure has been described in detail with reference to the specific example embodiment thereof, this is merely an example, and various changes, arrangements and modifications may be applied therein without departing from the spirit and scope of the disclosure.

What is claimed is:

1. A developing cartridge comprising:

a casing configured to accommodate developer therein;

a developing roller including a developing roller shaft extending in a first direction;

a first protrusion positioned at an outer surface of the casing, the first protrusion being rigid and protruding outward from the outer surface in the first direction; and

an electrode positioned at the outer surface, the electrode configured to be electrically connected to the developing roller shaft, the electrode including a second protrusion protruding outward in the first direction and the second protrusion having an inner space extending in the first direction, the inner space being positioned in the second protrusion, wherein the first protrusion is positioned in the inner space, and

wherein the second protrusion covers a distal end of the first protrusion.

2. The developing cartridge according to claim **1**, wherein the first protrusion extends from the outer surface of the casing.

3. The developing cartridge according to claim **1**, further comprising:

a supply roller configured to supply the developer to the developing roller, the supply roller including a supply roller shaft extending in the first direction,

wherein the electrode is configured to be electrically connected to the supply roller shaft.

4. The developing cartridge according to claim **1**, wherein the first protrusion has an outer end in the first direction and the outer end of the first protrusion is farther from the outer surface than an outer end of the developing roller shaft in the first direction.

5. The developing cartridge according to claim **1**, wherein the electrode is made of a conductive resin.

6. The developing cartridge according to claim **1**, wherein the electrode is attached to the outer surface.

7. The developing cartridge according to claim **1**, wherein the developing roller further includes a roller portion covering at least a portion of a circumference of the developing roller shaft,

wherein the casing includes a first wall and a second wall separated from the first wall in the first direction,

wherein the roller portion is positioned between the first wall and the second wall, and

wherein the first protrusion is positioned at an outer surface of the first wall and protrudes outward in the first direction.

8. The developing cartridge according to claim **1**, wherein the second protrusion is contactable with an electrical contact of an image forming apparatus when the developing cartridge is attached to the image forming apparatus.

9. The developing cartridge according to claim **1**, wherein the electrode is a bearing being made of a conductive resin.

10. A developing cartridge comprising:

a casing configured to accommodate developer therein;

a developing roller including a developing roller shaft extending in a first direction;

a first protrusion positioned at an outer surface of the casing, the first protrusion protruding outward from the outer surface in the first direction; and

an electrode positioned at the outer surface, the electrode configured to be electrically connected to the developing roller shaft, the electrode including a second protrusion protruding outward in the first direction and the second protrusion having an inner space extending in the first direction, the inner space being positioned in the second protrusion,

wherein the second protrusion has a first end portion and a second end portion, the first end portion and the second end portion arranged in a second direction crossing the first direction, the first end portion being closer to the developing roller shaft than the second end portion,

wherein the first protrusion is located in a part of the inner space, the part of the inner space being closer to the first end portion than the second end portion in the second direction.

11. A developing cartridge comprising:

a casing configured to accommodate developer therein;

a developing roller including a developing roller shaft extending in a first direction;

a first protrusion positioned at an outer surface of the casing, the first protrusion protruding outward from the outer surface in the first direction; and

an electrode positioned at the outer surface, the electrode configured to be electrically connected to the developing roller shaft, the electrode including a second protrusion protruding outward in the first direction and the second protrusion having an inner space extending in the first direction, the inner space being positioned in the second protrusion,

wherein the first protrusion is positioned in the inner space,

wherein the second protrusion has a first end portion and a second end portion, the first end portion and the second end portion arranged in a direction crossing the first direction, the first end portion being closer to the developing roller shaft than the second end portion,

wherein the developing cartridge further comprises:

a third protrusion protruding outward from the outer surface in the first direction, the third protrusion being positioned at an opposite side of the developing roller shaft with respect to the first protrusion; and

a fixing member configured to fix the second end portion to the third protrusion.

12. The developing cartridge according to claim **11**, wherein the second end portion has a through hole,

wherein the fixing member is inserted into the through hole and the fixing member is configured to fix the second end portion to the third protrusion.

13. The developing cartridge according to claim **12**, wherein the fixing member is a screw.

14. The developing cartridge according to claim **13**, wherein a portion of the second protrusion is positioned between an axis of the developing roller shaft and an axis of the screw.

15. The developing cartridge according to claim **11**, wherein the outer surface of the casing has a first surface and a second surface, the first surface extending in a second direction crossing the first direction, the second surface being farther from the outer surface than the first surface in the first direction,

wherein at least a portion of the first protrusion protrudes from the second surface, and

wherein the third protrusion protrudes from the first surface.

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